SCIENCE.

FRIDAY, MAY 29, 1885.

THE MONTEREY PINE AND CYPRESS.

BOTANISTS and tree-lovers have a special interest in Cupressus macrocarpa and Pinus insignis, on account of their very restricted native habitat, and for their value as ornamental trees. The first, the Monterey cypress, is known in the wild state only on the oceanic edge of that notable coniferous grove which extends for a few miles between the Bay of Monterey and the narrow inlet of Carmel; excepting, however, a few trees similarly situated, it is said, near Pescadero, farther north. The large cypress-trees of the Monterey grove, most picturesque in character and in position, are only a dozen or two in number. They are confined to the rocky and wind-beaten headland of the immediate shore. In view of their precarious position, it was gratifying to find, at certain points, that a goodly number of thrifty young trees were successfully competing with the pines for a short distance inland. Yet, hemmed in between the slowly encroaching ocean on one hand, and the forest of pines on the other, the future of this unique habitat is certainly precarious. Its companion, Pinus insignis, seems capable of holding its ground if left to nature. Besides this grove, in which it predominates, the tree naturally occurs here and there for some distance, perhaps on all the hills around Monterey Bay. The oldest and finest specimens I have seen of it are on the eastern side of the little town, accompanied by equally noble live-oaks (Quercus agrifolia), and forming that natural park — now adorned by the landscape-gardener's best art, and kept quite in the finish of an English nobleman's ancestral home — in which stands the noted Hotel del Monte.

It is no part of my object to commend the South Pacific railroad company for the establishment of this attractive resort. Its projectors will doubtless have their reward; but, considering the lavish outlay, one would think that a pecuniary return will be a long time in coming. But I do wish to commend them for an incidental service to botany and dendrology in rendering this habitat of the Monterey pine and cypress reasonably secure. With large and liberal foresight, this company bought the whole grove of Point Pinos and vicinity, supplied it with water from Carmel River, and also with about eighteen miles of drives, around the picturesque bluffs, among the hoary cypresses, and through the beautiful forest in various directions, making of the whole a park appertaining to the hotel, and watchfully caring for its preservation. The grove, fortunately, all belonged to one man, who inherited it: so that its acquisition was practicable, as it certainly was timely; for the trees would probably have been very soon cut away for lumber and firewood, and the ground cut up into building-lots.

Lamentable as the destruction of this grove would have been, yet these two trees would not be lost to California. They are extensively planted everywhere near the coast, especially in the southern part of the state, where they thrive wonderfully and grow rapidly, in situations that no other coniferous trees could well abide. At Monterey and at San Francisco the Monterey pine is most successfully used, in the manner of Pinus maritima in France, for the conversion of sand-dunes into forest. At Monterey many hundreds of trees, taken from the nursery at a foot or two in height, were growing healthfully when planted upon a sea-beach of drifting sand, hardly beyond the reach of winter's spray. At San Francisco this tree has played a conspicuous part in the conversion of a broad tract of shifting sand, which used to flow over into the town, into a beautiful park, already well furnished with trees and shrubs in great variety, as well as with grassy slopes and lawns, — the just pride of the city. Step by step this verdure and

welcome shelter is extending over the remaining sand-hills toward the ocean. The pine is preceded, first by the sand reed-grass (Ammophila), then by the wild lupines, especially by the two shrubby species of the place, — the yellow-flowered Lupinus arboreus, and the silvery-leaved and blue-flowered L. Chamissonis, — which in spring-time are as ornamental as they are useful.

These grounds were most wisely as well as beautifully laid out, the favorable natural configuration of the ground preserved and accentuated, the ample driveways led along easy curves around tree-plantations so placed as to afford very needful shelter from the sea-wind which gives an inclement character to a San Francisco summer. I was sorry to see, that, under a new administration of this park, these good points were not appreciated as they had been, perhaps because they are not apprehended. For changes by no means the better were in progress: the avenues were being widened and straightened to a certain extent, and shelter cut away, seemingly with the object of letting in the harsh west wind, or of facilitating fast driving. Neither of these results could be really desirable.

Although these two handsome trees, the Monterey pine and the Monterey cypress, are wholly unadaptable to the Atlantic United States, as may be said of almost every Californian conifer, it is pleasant to know that they grow fairly well in the warmer parts of England, where they are highly prized. Still the main hope of their perpetuity has respect to their native soil.

There is still another coniferous tree on the Californian coast of equally limited range and precarious destiny; namely, Pinus Torreyana of Parry. According to Dr. Parry (*West-American scientist*, i. 37), this tree "is confined to a coast-line of not more than four miles, and extending scarcely a mile inland," just below San Diego. Dr. Parry makes the timely suggestion that this precious bit of ground should be preserved by the town of San Diego, within the corporate limits of which it lies.

A. GRAY.

LETTERS TO THE EDITOR.

A novel snow-slide.

ON April 22 and 23 occurred the heaviest snow-fall known at this place. There was but little wind. The temperature was so mild that the flakes were slightly moist as they fell, and hence adhered firmly together. The snow was quite porous at first, but rapidly settled, and became somewhat compact. On tinned roofs and on steep shingled roofs, snow-slides of the common sort were frequent; but, on shingled roofs of moderate slope, I noticed that the snow was slowly moving downwards somewhat like a glacier. The thickness of the snow after settling was about ten inches; and its rate of motion downward varied from one inch to two feet per hour, according to situation. At the eaves it bent downward like a plastic mass, and hung in broad sheets in the air until breaking by its own weight. I have often seen the same thing, but never on so large a scale. In one case, on the north side of a building, the snow-sheet retained the curve which it took as it passed the edge of the roof. It thus bent inward so as to nearly touch the building four feet below the cornice. Measured along the curve, the suspended portion was about five and a half feet long, which certainly shows considerable tenacity of the snow-sheet, considering that it had fallen within thirty-six hours, and that the temperature was such that there was a constant drip of water from the edge of the snow. It should be noted, that, at the last, the whole mass — both the suspended portion and that on the roof — went down in a body, with no breaks anywhere. G. H. STONE.

Colorado Springs, April 25.

A parasitic leech.

In the summer of 1877, at Fort Bridger, Wyoming, while partaking of the hospitality of my friend Dr. J. Van A. Carter, a Shoshone Indian brought to the house a fish to be served for the table. It was caught in the neighboring stream, Black's Fork of Green River, and was known in the locality as the 'Hela' (Gila?), or whitefish. I made it out to be the so-called Colorado pike, Ptychochilus lucius. It was upwards of two feet in length. My attention was directed to it by Dr. Carter, who informed me that the fish was liable to be infested with leeches in the mouth. On examining the specimen, I detected a dozen leeches suspended to the sides of the tongue by their terminal sucker. On disturbance, they became very lively, clinging tightly to their position, alternately elongating and shortening, and projecting and retracting, the head extremity in the usual manner of their allies. They appeared of a translucent blackish hue, with eight longitudinal, equidistant, raw-sienna colored stripes. In the contracted state they were from an inch to an inch and a quarter long by less than half an inch broad, elliptical, and with the head extremity rather abruptly narrowed and more or less prolonged. Elongated, they were up to two and a half inches by about one-third of an inch at the broadest part, and, as represented in the accompanying figure, which is of the natural size, were variably cylindro-clavate, thickest behind, and tapering forward, and more or less constricted at different points. The caudal sucker, by which the leech tightly adhered to its position, was of the usual circular form and proportions. After removing the tongue of the fish, and laying it in a dish of water, in the course of an hour the leeches voluntarily detached themselves, and moved about, or clung to the bottom of the dish. The integument is smooth,

thin, and transparent, so that the chief organs within were visible through it. There were no eye-spots. The mouth, when expanded, appeared as an ovoid sucker, with the orifice somewhat diamond-shaped; and it was neither armed with teeth, nor provided with a proboscis. The oesophagus is narrow, and opens into a capacious stomach, which forms ten or eleven horizontal discoid saccules, which were filled with a blackish-brown liquid, apparently blood. The stomach is surrounded by eight tortuous, gland-like organs, which extend the entire length of the body, and give rise to the colored stripes seen through the skin. These organs are composed of numerous pyriform acini, and appear like racemose glands, but their nature I did not determine. The specimens were preserved in alchohol with the view of further investigation, but they have softened to such a degree that the examination has proved unsatisfactory. From the conspicuous gland-like organs and the habit of the leech, I propose to name it Adenobdella oricola.

In the stomach of the same fish there were some little tape-worms, which I suppose to be the Taenia torulosa, originally described from European species of Leuciscus and other species of the same family. The worms were white, filiform, compressed cylindrical, and from three to six inches long. The head is oval, without rostrum or hooks, and with four equidistant, spherical, immersed bothria. The neck is narrowed and moderately long. The body widens to the posterior fourth, and then gradually narrows. The segments are wider than long, and not prominent. The generative apertures are marginal, with the penes projecting; diameter of the head, one-third of a line; greatest breadth of the body, three-fourths of a line.

JOSEPH LEIDY.

Mortality experience of life-insurance companies.

That figures have a great capacity for lying, and that nothing needs closer watching than an argument based on statistics, are facts which ought to be well impressed on everybody's mind. On almost every subject of public importance, — politics, finance, economic policy, social science, — one is continually solicited to believe in this or that doctrine because statistics 'prove' it to be true. And a large part of the error that prevails on many of these subjects — notably, on the question of free trade and protection — is due, on the one hand, to the reckless way in which statistics are handled by writers, and, on the other, to the absence among their readers of a wholesome suspicion of statistical arguments, and of the abiding consciousness that statistics do not always mean what they seem at first sight to say.

Such being the case, it is a pity that Professor Newcomb — than whom surely no one is more free from the mental defects to which these errors are usually due — should have made so many slips in a recent article in *Science* on mortality statistics. One cannot help asking whether Homer's nods come, like misfortunes, many at a time.

A curious logical slip occurs in the passage relating to the influence of occupation upon mortality. "How little mere occupation has to do with viability, is shown by the fact, that, while bankers and capitalists suffer one-fourth less, brokers, speculators, and operators suffer twelve per cent more, than the tabular mortality." In other words, from the fact that in two occupations seemingly very similar the rates of mortality are widely different, the inference is drawn that occupation has little or nothing to do with the matter. Obviously, the true inference is, that either the statistics are inadequate to the making of the comparison in question, or that the occupations which seemed to be similar are really widely different. If we are sure the occupations are practically alike, we must conclude that the statistics are insufficient, or subject to a bias: if we are sure that the statistics are sufficient and impartial, we must conclude that some important difference is to be found in the occupations; and, in point of fact, there is a very striking difference between the calling of an operator in stocks and that of a legitimate banker or sound capitalist.

In the same paragraph we are told that travelling-agents have the greatest viability of all. This is somewhat surprising; but the fact is deprived of all significance when one finds, on turning to the tables, that the total number of deaths in this class was only eight. So with regard to the excessive mortality of the younger class. The whole number of deaths between the ages of seven and twenty is forty-seven, as Professor Newcomb mentions, while the American table would make it thirty-three. An aggregate excess of fourteen deaths is too slender a basis to rest any inference upon, and is not so surprising as to render an explanation absolutely necessary. It happens, however, that it is in a great measure explained by the fact that (as pointed out in the text accompanying the tables) almost the entire excess occurs among the lives insured under term-policies; i.e., policies issued to extend over a particular period only, and taken for the purpose of covering special risks.

As to the most important point discussed by Professor Newcomb, — whether Herbert Spencer, and those who share his 'superstition,' are right in believing that the most active and enterprising Americans injure their health, and shorten their lives, by too great devotion to business, — I cannot think that these mortality statistics are any thing like a 'sure test' of the question. The class referred to is mixed up with other classes; and, unless we can compare the mortality in this class with the mortality in the same class in England, our inferences must be very guarded indeed. Moreover, there are many things affecting selection — strictness of examination, privilege of surrender, popularity of life insurance — which may greatly differ in the two countries, and largely influence the result. The great excess of mortality in the case of term-policies, and the considerable deficiency in the case of paid-up policies, shown by the Connecticut mutual tables, are instances of this sort of phenomenon. And, even if we were in possession of a perfectly fair comparison with Englishmen, it would still remain to consider whether Americans would not, in the absence of habits complained of, compare still more favorably with Englishmen. On the question of the effect of overwork, and worry, and ambition to become rich, a little bold *a priori* reasoning is likely to lead to a sounder result than can be derived from statistics not specially designed to test the question. It may be remarked, as throwing some light on the matter, that the actuary of the Connecticut company, after observing that between the ages of fifty-six and seventy-five an undue proportion of the deaths occur among those insured for large amounts, adds, "These results suggest the question whether those who insure for large amounts — often, perhaps generally, men of good incomes,

and living well, but involved in the cares, and burdened with the responsibilities, of great business enterprises — are more liable than other men to break down and die at about these latter ages." The comparison here instituted — between Americans who belong to the classes to which Herbert Spencer's strictures chiefly refer, and other Americans — seems much more likely to lead to a reliable result than a comparison between Americans and Englishmen. F. F.

An attempt to photograph the solar corona.

Judging by the tone of Dr. Huggins's communication in *Science* for May 15, I think he fails to understand a point I particularly emphasized in my communication of April 3; namely, that I was not criticising his work, but merely stating the results of my own investigations. I have not, as yet, had an opportunity to experiment with a reflector; but, when we consider the greater visibility of minute companions of bright stars in refractors as compared with reflectors, it does not seem evident how chromatic aberration and internal reflection from the surfaces of a lens can totally unfit it for work, which, according to Dr. Huggins, is perfectly possible for a reflector. In the mean time, an account of some experiments which I have recently made with my refractor may be of interest.

Dr. Huggins suggests that the dark fringe on the negative, which was obtained around the sun, is largely due to diffraction at the instants of opening and closing my shutter. If this were so, the darkening should extend farthest, and be most marked in the direction parallel to the line of motion of the shutter, and should be almost *nil* in the direction at right angles to this line. A careful inspection of my results shows no such effect, the greatest darkening lying sometimes in one direction, and sometimes in another. I therefore think that this objection, although theoretically sound, is not of practical importance with my apparatus. The real causes which would tend to produce a dark fringe around the sun's image are fourfold, and may be classified as follows: (*a*) the solar corona, (*b*) the atmospheric reflection, (*c*) instrumental defects, (*d*) photographic properties of the plate. In the last class I include chemical reduction of the particles of the silver salt contiguous to reduced particles of metallic silver; also halos produced by insufficient backing, and irregularities in the film itself. At the time of a partial solar eclipse, the effect of the corona alone is removed from around a portion of the sun's limb, the other three causes of the darkening remaining. By photographing the sun when its disk is half hidden behind a high neighboring building, the first two causes alone of the darkening are removed. By pasting a strip of black paper across the middle of the plate in such a position that the sun's image shall fall, half on the paper, and half on the plate, and then, before development, removing the paper, the first three causes alone of the darkening will be removed, leaving the fourth. By these devices the effect of each of these four causes has been sifted out, and the relative importance of each determined.

Dr. Huggins claims that my results are due almost wholly to instrumental defects, and not to atmospheric reflection. In this I think he is mistaken. The dark fringe is in part due to both causes; but, even in the clearest weather, the part due to atmospheric reflection is still prominent. Dr. Huggins says, "When the sky is free from clouds, but white from a strong scattering of the sun's light, the sun is well defined upon a *sensibly uniform*[1] surrounding of air-glare, but without any indication of the corona. It is only when the sky becomes clear and blue in color that coronal appearances present themselves with more or less distinctness." I do not know what to make of this statement; for it certainly runs counter to all that one would naturally expect, to all visual experience, and to all my photographic results. As every one knows, whether the sky is clear or hazy, that portion of it in the immediate vicinity of the sun is considerably brighter than those portions more remote. To test the matter photographically, on a hazy day such as he describes, I took a picture of the sun when it was half hidden behind a high building. If, as he claims, the dark fringe was due solely to instrumental defects, it should be equally well marked all round the semicircular image of the sun. If, on the other hand, it were due solely to atmospheric reflection, the part protected by the chimney should be entirely devoid of halo. On development, a very strong halo surrounded the sun's image, going as far round as the brick wall. Here it abruptly ceased, and was replaced by a barely perceptible darkening along the straight side of the image. This increase of brilliancy on approaching the sun's limb was very marked. This appearance can be verified by any one visually with a piece of colored glass. It therefore appears evident that a great part of the corona-like fringe shown in my photographs is due to causes outside of the instrument, and hence cannot be diminished by changes in the latter. On the photographs taken at the time of the eclipse, the fringe was as strongly marked in front of the moon as on the other side of the sun. It therefore appears that the effect of the corona was imperceptible as compared with the effect of the other sources of light, although the atmospheric conditions were exceptionably favorable. On a clear day the atmospheric reflection is less marked than on a hazy one, but is still always present. I hope soon to repeat the experiment with an instrument closely resembling that of Dr. Huggins, although the advantages of his form of apparatus do not seem very evident to me.

[1] The italics are my own.

There are one or two points raised in Dr. Huggins's article which should be answered here. As stated in *Science*, April 17, all the plates employed were backed with asphalt varnish. The image of the sun obtained through the violet glass was not reversed, although there is no question but that it would have been, as Dr. Huggins suggests, by a longer exposure. I did not care for a 'different result,' and merely made the statement as one of the facts observed under the conditions named. Dr. Huggins objects to my reference to Dr. Lohse, maintaining that his 'published statement reads differently.' But, in fact, Dr. Lohse only states, that, after overcoming certain difficulties, results were obtained which justify a continuation of the experiments. He does not state that he considers his results coronal, but merely that a continuation of the experiments would be desirable, in which statement I thoroughly agree with him. As I do not feel at liberty to print a private letter, I have written to Dr. Lohse for an exact expression of his views.

WM. H. PICKERING.

Institute of technology, Boston, Mass.

A BRONZE MEDALLION PORTRAIT OF DR. ASA GRAY.

WE present to our readers on the opposite page a faithful copy of the admirable bronze medallion, by Saint Gaudens, of Professor Asa


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Gray of Harvard university, now on exhibition at the Art museum in Boston. It is an excellent likeness of our distinguished botanist, and a fine specimen of the artist's peculiar work. It has the earnestness and geniality of expression which the passing years seem to impress more forcibly upon Dr. Gray's countenance; and the artist has so wrought the stubborn material as to impart grace and apparent flexibility to the flowing locks. This admirable work of art, representing, as it does in such a thoroughly artistic manner, one of the leading scientific men of America, will be worthily placed upon the walls of the college halls, with which his name and fame will be forever associated. It is a gift to the college from some of the friends and associates of the professor, who have adopted this method of expressing their regard and admiration for his character and scientific achievements.

THE HONG SAL MUN, OR THE RED ARROW GATE.

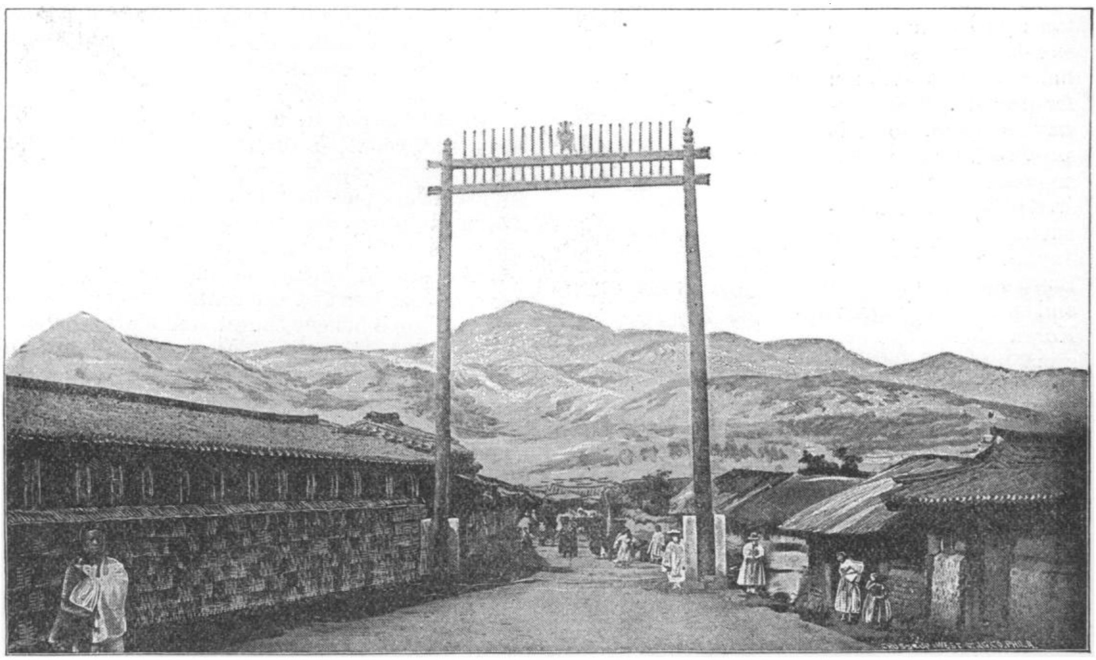
ONE of the most striking characteristics of far eastern architecture is the singular respect paid to approaches. The means, it may be said, is itself the end. It is not so much what you are to reach, as how you are to reach it, that the Korean deems important. The practice is one branch of the all-pervading ceremonial. To his mind the dignity of an object is best preserved by rendering the access to it imposing. What we see in a nest of Chinese boxes, one within the other, is an illustration of exactly the same principle: the object always eventually found contained in the innermost is enhanced in value just in proportion to the difficulty of getting at it.

The approaches vary in kind according to the degree of intimacy they bear to the main building. First and outermost stands what is called in Korean the Hong Sal Mun, or 'red arrow gate.' This is a singularly odd and strikingly unique structure, and to the student it derives still further interest from being purely tartar. In origin it is religious, or, more exactly, superstitious: for it dates back to the earliest spirit-worship, — the old mythological days, when a hero was a demigod and a king by ancestry divine; and so, because of his genealogy, it was erected as an outer portal to his gates. For in the aboriginal faith, unchanged to this day, the king is the lineal descendant of the gods, and their representative and mediator to men. Nor did the custom stop there. His glory was reflected upon those who carried out his will, — the official class. From his mansion it was copied for theirs; so that now the distinctive mark of a magistracy is the red arrow gate. This is what it is in Korea. But it is all the more interesting that its acquaintance was not made there. In fact, till now, its presence there was not known. It was in Japan that this curious structure first came to the notice of the western world, and then in connection with temples. It is known there by the name of *torii*, commonly but questionably translated as 'bird's rest.' Originally the portal to Shintō shrines, it was borrowed by Buddhism, and now guards indifferently the approach to buildings of either religion. In this it differs entirely from the use to which it is put in Korea, for there it never does service to Buddhist temples. At first sight, the reason is perhaps not evident; yet its use in the one land explains collaterally its use in the other, and points to a primitive idea, of which both are natural though different applications. In Japan, the mikado is a son of heaven, and head of the Shintō faith, which is the aboriginal belief; church and state are one, Buddhism being but a later addition to the religious wealth of the country; and, by a mistaken analogy only, Buddhism came to make use of this gate, to which, in truth, it was perfectly alien. In Korea, on the other hand, the state is all in all. Instead of the state merging into the church, the church was swallowed up, at least in its outward expressions, by the state. Then, when Buddhism came to be ingrafted on the country, there was no excuse, such as existed in Japan, to give it what had then ceased to be looked upon as peculiarly religious: so it continued to be employed, as before, entirely as a sign of kingly authority, and was never converted into another symbol of Buddhistic show.

Its form differs slightly from that of its Japanese counterpart. It wants the graceful curves that make that so beautiful a structure by itself. It lacks also the other's diversity of material. It is built invariably of wood, and its claim to attention arises rather from a certain quaint grotesqueness than from any intrinsic beauty. Two tall posts, slightly inclined to one another, are crossed by a third, and bound together a short distance above the crossing by still a fourth. All four are perfectly straight. Starting from the lower, and projecting beyond the upper horizontal piece, is a row of vertical beams of wood, spear-shaped. These are the arrows of the name. In the centre is a design as singular to the eye as it is peculiar for its mystic meaning; two

spirals, coiled together, filling the area of a circle. They are emblematic of the positive and negative essences of Chinese philosophy. Above them is the representation of tongues of flame. All this typifies the power of the king, joined, since the nation espoused the morality of Confucius, with a reverence for the sage. As the name implies, the whole is painted a bright red, which, in Korea, is the kingly color. Its height is from thirty to forty feet.

Its situation is striking. It rises by itself in solitary grandeur. It is not connected with either walls or buildings. It stands alone and apart. Nor has it any particular position assigned it. It may stand near to, or far from, the shrine or the magistracy to which it leads. Placed only at a respectful distance, it fulfils but the one condition, — that it shall face what it foretells. It is there to direct the thought as much as to impress the mind. In Japan, where certain mountains are sacred, and worshipped as shrines, it is often met with tens of miles away from what it heralds; alone in the midst of nature, on the top of some high mountain pass, over which lies the road, and from whose summit the pilgrim catches the first view of the desired goal, framed in like a picture between its posts. In Korea it commonly spans the street; so that, in so far at least, passers-by do the king homage. But this is simply because the street is the natural approach. In the rural districts, where the street is wider, the portal's span of twenty feet can only occupy the centre, while the thoroughfare is as much around as under it. And yet so compelling is ceremonial that no one would think of entering save beneath its arch; and in Japan it is counted little short of sacrilege by properly superstitious persons, on their way to the temple or the shrine, to avoid it by going around.



THE RED ARROW GATE IN KOREA.

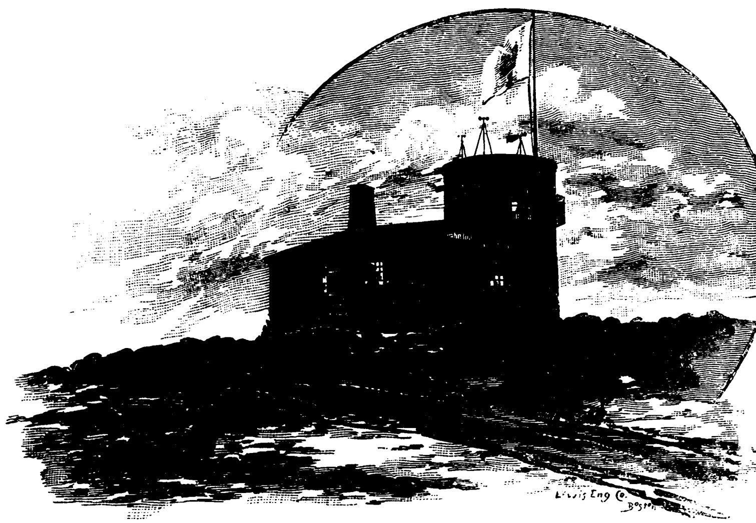
Its discovery in Korea is further interesting as supplying another presumption, amounting almost to proof, in favor of the opinion expressed by Mr. Chamberlain of Tokio, that the ordinarily received meaning of the Japanese name for it, *torii* ('bird's rest'), is erroneous. This is the meaning of the Chinese characters by which it is at present expressed. But though these are the only direct and positive evidence in the matter, they are nevertheless but *prima facie* proof. The Japanese language existed before ever the Chinese ideographs were adopted to write it, and therefore the ideographs with which any word is now written are only evidence of what was considered to be the meaning of that word at the time they were adopted. There is always be-

hind this the Japanese derivation of the word, which, though possible, of course, in the way the characters express it, may be possible also in another way, and that other may really be the true one. Following this course, Mr. Chamberlain suggests that *torii* is not derived from *tori* ('a bird') and *i* ('to be or rest'), but from *tōri* ('to pass through') and *i* ('to be'), which would make it 'a place of passing through.'

To account for such an improbable name as 'bird's rest,' it is customary to instance the well-known respect of the Buddhist religion for animals. The gateway is there, so it is said, to afford a roosting-place for the sacred pigeons which frequent many of the Japanese temples. But as we see, again and emphatically, from Korea, there is no original connection between Buddhism and the *torii;* for the red arrow gate has, in the peninsula, nothing whatever to do with Buddhist temples, and its name there is simply explanatory of its structure. This does not prevent birds roosting on it, as one happened to do at the moment the accompanying photograph was taken, for it must be for them an exceedingly convenient place to roost. But its popularity in Korea at least suggests, that, as regards the custom of the Japanese pigeons, the name probably followed the fact, rather than the fact a dedication. PERCIVAL LOWELL.

THE METEOROLOGICAL OBSERVATORY ON BLUE HILL.

THE meteorological observatory lately constructed by Mr. A. Lawrence Rotch on the summit of Blue Hill, near Boston, at an elevation of six hundred and thirty-five feet, is now in working order; and two monthly bulletins have been issued from it, containing summaries of winds and weather for February and March of the current year. The only other observatories in this country, elevated distinctly above the surrounding region, are those maintained by the U.S. signal-service on Mount Washington and at Pike's Peak, both of which are at elevations greatly above that of Blue Hill. At the level of Pike's Peak, the cyclonic rotation of the winds is hardly observable, the observatory there being above the strata of the atmosphere whose circulation is seriously disturbed by passing storms. On Mount Washington the winds whirl around almost in a circle about the progressing storm-



centre. At Blue Hill we may hope to discover the true circulation of the lower air, unaffected by the natural or artificial irregularities of surface that modify the records of so many of our signal-service stations. The value of observations taken at moderate elevations is attested by the increasing number of mountain observatories in Europe. Ben Nevis is the latest on the list, and its records have already afforded material for several articles in *Nature* and other foreign journals. Germany has a station on the Brocken; France, on the Puy de Dôme and the Pic du Midi; while Switzerland possesses several more. As Blue Hill has the first private observatory of the kind in this country, we shall look with especial interest for the results of studies based upon its records. The accompanying figure is from a photograph taken by the observer, Mr. W. P. Gerrish. The large 'cold-wave' flag, when displayed from the pole on the tower, according to the signal-service predictions, can be seen by a number of villages around the base of the hill. An account of the building was read at a recent meeting of the New-England meteorological society, and published in the December number of the *American meteorological journal.* W. M. D.

AQUATIC PLANTS OF SAN DIEGO.

DURING the wet spring of 1884 I had an excellent opportunity to note the aquatic flora of this vicinity. Doubtless it seldom reaches such luxuriance; and in some years, owing to the scarcity of water, many of the plants certainly make no appearance.

Surface-water reached an exceedingly low stage in 1883; and San Diego was supposed remarkably free from any water-plants, except the wide-spread Azolla, and a few other well-known species. However, the heavy rains of 1884, flooding the entire country, revealed a surprisingly large variety; and that, too, where one would least expect it, — on the broad, usually dry and barren mesas.

The surface-geology of large portions of these mesas is characterized by innumerable hillocks, or small mound-like formations, rising from one to four feet above the intervening depressions, and ranging from ten to fifty feet in diameter. They are generally nearly circular, though often irregular; and the depressions contain in stony places accumulations of cobblestones.

These innumerable hollows naturally become miniature lagoons as soon as heavy rains commence; and soon the leaves of Callitriche are floating upon their surface, while the deeper portions of the little lakes are lined upon the bottom with large patches of Pilularia Americana, Tillaea angustifolia (Nutt.), and Elatine; and along the borders are other minute plants which altogether form a tangled mat of miniature luxuriance, exceeding in comparison the vegetation of the largest lakes. Some of the larger pools, longer covered with water, are filled along the edges with junci, sedges and grasses, among which, at the bottom, Isoetes thrives as well as in the northern lakes.

Later in the season, Downingia pulchella and Pogogyne nudiuscula, with several less conspicuous species, border the pools; and still later a new golden Bloomeria, blue Brodiaeas, and other beautiful Liliaceae, are found; and these, in turn, give way to a few Compositae, preceding the next dry season.

This year another plant, Marsilia vestita, common to lagoons at high altitudes, and also Ammannia latifolia (L.) and Echinodius rostratus (Engelm.), grew abundantly in this vicinity, on the borders of a usually dry flat, near the level of the sea. Other aquatics were found in great quantity throughout the country; and nearly two dozen species of common water-plants, previously unknown to this section, were added to the local flora. C. R. ORCUTT.

SUNLIGHT AND THE EARTH'S ATMOSPHERE.[1]

THERE is, we may remember, a passage in which Plato inquires what would be the thoughts of a man who, having lived from infancy under the roof of a cavern, where the light outside was inferred only by its shadows, was brought for the first time into the full splendors of the sun. We may have enjoyed the metaphor without thinking that it has any physical application to ourselves, who appear to have no roof over our heads, and to see the sun's face daily; while the fact is, that if we do not see that we have a roof over our heads in our atmosphere, and do not think of it as one, it is because it seems so transparent and colorless.

Now, I wish to ask your attention to-night to considerations in some degree novel, which appear to me to show that it is not transparent, as it appears, and that this seeming colorlessness is a sort of delusion of our senses, owing to which we have never in all our lives seen the true color of the sun, which is in reality blue rather than white, as it looks; so that this air all about and above us is acting like a colored glass roof over our heads, or a sort of optical sieve, holding back the excess of blue in the original sunlight, and letting only the white sift down to us. I will first ask you, then, to consider that this seeming colorlessness of the air may be a delusion of our senses, due to habit, which has never given us any thing else to compare it with.

If that cave had been lit by sunshine coming through a reddish glass in its roof, would the perpetual dweller in it ever have had an idea but that the sun was red? How is he to know that the glass is 'colored,' if he has never in his life any thing to compare it with? How can he have any idea but that this is the sum of all the sun's radiations (corresponding to our idea of white or colorless light)? Will not the habit of his life confirm him in the idea that the sun is red? and will he not think that there is no color in the glass, so long as he cannot go outside to see? Has this any suggestion for us, who have none of us ever been outside our crystal roof to see? We must all acknowledge in the abstract, that habit is equally strong in us, whether we dwell in a cave or under the sky; that what we have thought from infancy will probably appear the sole possible explanation; and that, if we want to break its chain, we should put ourselves, at least in imagination, under conditions where it no longer binds us.

The Challenger has dredged from the bottom of the ocean fishes which live habitually at great depths, and whose enormous eyes tell of the correspondingly faint light which must have descended to them through the seemingly transparent water. It will not be so futile a speculation as it may at first seem, to put ourselves in imagination in the condition of creatures under the sea, and ask what the sun may appear to be to them; for, if the fish who had never

[1] A lecture delivered at the Royal institution, April 17, 1885, by Prof. S. P. LANGLEY of Alleghany. From advance sheets of *Nature*, kindly furnished by the editor.

risen above the ocean-floor were an intelligent being, might *he* not plausibly reason that the dim greenish light of his heaven — which is all he has ever known — was the full splendor of the sun, shining through a medium which all his experience shows is transparent? We ourselves are, in very fact, living at the floor of a great aerial sea, whose billows roll hundreds of miles above our heads. Is it not, at any rate, conceivable that we may have been led into a like fallacy from judging only by what we see at the bottom? May we not, that is, have been led into the fallacy of assuming that the intervening medium above us is colorless because the light which comes through it is so?

I freely admit that all men, educated or ignorant, appear to have the evidence of their senses that the air is colorless, and that pure sunlight is white; so that, if I venture to ask you to listen to considerations which have lately been brought forward to show that it is the sun which is blue, and the air really acts like an orange veil, or like a sieve which picks out the blue and leaves the white, I do so in the confidence that I may appeal to you on other grounds than those I could submit to the primitive man, who has his senses alone to trust to; for the educated intelligence possesses those senses equally, and, in addition, the ability to interpret them by the light of reason; and before this audience it is to that interpretation that I address myself.

Permit me a material illustration. You see through this glass, which may typify the intervening medium of air or water, a circle of white light, which may represent the enfeebled disk of the sun when so viewed. Is this intervening glass colored, or not? It seems nearly colorless; but have we any right to conclude that it is so because it seems so? Are we not *taking it for granted* that the original light which we see through it is white, and that the glass is colorless because the light seems unaltered? and is not an appeal to be made here from sense to reason, which, in the educated observer, recalls that white light is made of various colors, and that whether the original light is really white and the glass transparent, or the glass really colored and so *making* the white, is to be decided only by experiment, by taking away the possibly deceptive medium? I can take away this glass, which was not colorless, but of a deep orange, and you see that the original light was not white, but intensely blue. If we could take the atmosphere away between us and the sun, how can we say that the same result might not follow? To make the meaning of our illustration clearer, observe that this blueness is not a pure spectral blue. It has in it red, yellow, blue, and all the colors which make up white, but blue in superabundance; so that, though the white is, so to say, latent there, the dominant effect is blue. The glass colored veil does not put any thing *in*, but acts, I repeat, like a sieve straining *out* the blue, and letting through to us the white light which was there in the bluishness; and so may not our air do so too?

I think we already begin to see that it is, at any rate, conceivable that we *may* have been hitherto under a delusion about the true color of the sun, though of course this is not proving that we have been so. And it will at any rate, I hope, be evident that here is a question raised which ought to be settled: for the blueness of the sun, if proven, evidently affects our present knowledge in many ways, and will modify our present views in optics, in meteorology, and in numerous other things, — in optics, because we should find that white light is *not* the sum of the sun's radiations, but only of those dregs of them which have filtered down to us; in meteorology, because it is suggested that the temperature of the globe, and the condition of man on it, depend in part on a curious selective action of our air, which picks out parts of the solar heat (for instance, that connected with its blue light), and holds them back, letting other selected portions come to us, and so altering the conditions on which this heat by which we live depends; in other ways innumerable, because, as we know, the sun's heat and light are facts of such central importance, that they affect almost every part of scientific knowledge.

It may be asked, What suggested the idea that the sun may be blue rather than any other color? My own attention was first directed this way many years ago, when measuring the heat and light from different parts of the sun's disk. It is known that the sun has an atmosphere of its own, which tempers its heat, and by cutting off certain radiations, and not others, produces the spectral lines we are all familiar with. These lines we customarily study in connection with the absorbing vapors of sodium, iron, and so forth, which produce them; but my own attention was particularly given to the regions of absorption, or to the color it caused; and I found that the sun's body must be deeply bluish, and that it would shed blue light, except for this apparently colorless solar atmosphere which really plays the part of a reddish veil, letting a little of the blue appear on the centre of the sun's disk where it is thinnest, and staining the edge red, so that to delicate tests the centre of the sun is a pale aqua-marine, and its edge a garnet. The effect I found to be so important, that, if this all but invisible solar atmosphere were diminished by but a third part, the temperature of the British Islands would rise above that of the torrid zone; and this directed my attention to the great practical importance of studying the action of our own terrestrial atmosphere on the sun, and the antecedent probability that our own air was also and independently making the really blue sun into an apparently white one. We actually know, then, beyond conjecture, by a comparison of the sun's atmosphere where it is thickest, and where it is thinnest, that an apparently colorless atmosphere *can* have such an effect; and analogous observations which I have carried on for many years, but do not now detail, show that the atmosphere of our own planet, this seemingly clear air in which we exist like creatures at the bottom of the sea, does do so. We look up through our own air as through something so limpid in its purity, that it appears scarcely matter at all; and we are apt to forget the enormous mass of what seems of such

lightness, but which really presses with nearly a ton to each square foot, so that the weight of all the buildings in this great city, for instance, is less than that of the air above them.

I hope shortly to describe the method of proof that it, too, has been acting like an optical sieve, holding back the blue; but it may naturally be asked, Can our senses have so entirely deceived us that they give no hint of this truth, if it be one? Is the appeal wholly to recondite scientific methods, and are there no indications, at least, which we may gather for ourselves? I think there are, even to our unaided eyes, indications that the seemingly transparent air really acts as an orange medium, and keeps the blue light back in the upper sky.

If I hold this piece of glass before my eyes, it seems colorless and transparent; but it is proved not to be so by looking through it edgewise, when the light, by traversing a greater extent, brings out its true color, which is yellow. Every one knows this in every-day experience. We shall not get the color of the ocean by looking at it in a wineglass, but by gazing through a great depth of it; and so it is with the air. If we look directly up, we look through where it is thinnest; but if we look horizontally through it towards the horizon, through great thicknesses, as at sunrise or sunset, is it not true that this air, where we see its real color most plainly, makes the sun look very plainly yellow or orange? We not only see here, in humid English skies, the 'orange sunset waning slow,' but most of us, in these days of travel, can perfectly testify that the clearest heavens the earth affords, the rosy tint on the snows of Mont Blanc, forerunning the dawn, or the warm glow of the sun as he sets in Egyptian skies, show this most clearly, — show that the atmosphere holds back the blue rays by preference, and lets the orange through.

If next we ask, What has become of the blue that it has stopped? does not that very blue of the mid-day sky relate the rest of the story, — that blue which Professor Tyndall has told us is due to the presence of innumerable fine particles in the air, which act selectively on the solar waves, diffusing the blue light towards us? I hope it will be understood that Professor Tyndall is in no way responsible for my own inferences ; but I think it is safe, at least, to say that the sky is not self-luminous, and that, since it can only be shining blue at the expense of the sun, all the light this sky sends us has been taken by our atmosphere away from the direct solar beam, which would grow both brighter and bluer if this were restored to it.

If all that has been said so far renders it possible that the sun may be blue, you will still have a right to say that 'possibilities' and 'maybes' are not evidence, and that no chain of mere hypotheses will draw truth out of her well. We are all of one mind here, and I desire next to call your attention to what I think is evidence.

Remembering that the case of our supposed dweller in the cave who could not get outside, or that of the inhabitants of the ocean-floor who cannot rise to the surface, is really like our own, over whose heads is a crystalline roof which no man from the beginning of time has ever got outside of, — an upper sea to whose surface we have never risen, — we recognize that if we could rise to the surface, leaving the medium whose effect is in dispute wholly beneath us, we should see the sun as it is, and get proof of an incontrovertible kind ; and that, if we cannot entirely do this, we shall get nearest to proof under our real circumstances by going as high as we can in a balloon, or by ascending a very high mountain. The balloon will not do, because we have to use heavy apparatus requiring a solid foundation. The proof to which I ask your kind attention, then, is that derived from the actual ascent of a remarkable mountain by an expedition undertaken for that purpose, which carried a whole physical laboratory up to a point where nearly one-half the whole atmosphere lay below us. I wish to describe the difference we found in the sun's energy at the bottom of the mountain, and at the top, and then the means we took to allow for the effect of that part of the earth's atmosphere still over our heads even here, so that we may be said to have virtually got outside it altogether.

Before we begin our ascent, let me explain more clearly what we are going to seek. We need not expect to find that the original sunlight is a pure monochromatic blue by any means, but that though its rays contain red, orange, blue, and all the other spectral colors, the blue, the violet, and the allied tints were originally there in disproportionate amounts; so that, though all which make white were present from the first, the refrangible end of the spectrum had such an excess of color, that the dominant effect was that of a bluish sun. In the same way, when I say briefly that our atmosphere has absorbed this excess of blue and let the white reach us, I mean, more strictly speaking, that this atmosphere has absorbed *all* the colors, but selectively taking out more orange than red, more green than orange, more blue than green; so that its action is wholly a taking-*out*, — an action like that which you now see going on with this sieve, sifting a mixture of blue and white beads, and holding back the blue, while letting the white fall down.

This experiment only rudely typifies the action of the atmosphere, which is discriminating and selective in an amazing degree ; and, as there are really an infinite number of shades of color in the spectrum, it would take forever to describe the action in detail. It is merely for brevity, then, that we now unite the more refrangible colors under the general word 'blue,' and the others under the corresponding terms 'orange' or 'red.'

All that I have the honor to lay before you is less an announcement of absolute novelty than an appeal to your already acquired knowledge, and to your reason as superior to the delusions of sense. I have, then, no novel experiment to offer, but to ask you to look at some familiar ones in a new light. We are most of us familiar, for instance, with that devised by Sir Isaac Newton to show that white light is compounded of blue, red, and other colors, where, by

turning a colored wheel rapidly, all blend into a grayish white. Here you see the 'seven colors' on the screen; but, though all are here, I have intentionally arranged them so that there is too much blue, and the combined result is a very bluish white, which may roughly stand for that of the original sun-ray. I now alter the proportion of the colors so as to virtually take out the excess of blue, and the result is colorless or white light. White, then, is not necessarily made by combining the 'seven colors,' or any number of them, unless they are there in just proportion (which is in effect what Newton himself says); and white, then, may be made out of such a bluish light as we have described, not by putting any thing to it, but by taking away the excess which is there already.

Here, again, are two sectors, — one blue, one orange-yellow with the blue in excess, — making a bluish disk where they are revolved. I take out the excess of blue, and now what remains is white. Here is the spectrum itself on the screen, but a spectrum which has been artificially modified so that the blue end is relatively too strong. I recombine the colors (by Professor Rood's ingenious device of an elastic mirror), and they do not make a pure white, but one tinted with blue. I take out the original excess of blue, and what remains combines into a pure white. Please bear in mind that when we 'put in' blue here, we have to do so by straining out other light through some obscuring medium, which makes the spectrum darker, but that, in the case of the actual sunlight, introducing more blue introduces more light, and makes the spectrum brighter.

The spectrum on the screen ought to be made still brighter in the blue than it is, — far, far brighter, — and then it might represent to us the original solar spectrum before it has suffered any absorption either in the sun's atmosphere or our own. The Fraunhofer lines do not appear in it; for these, when found in the solar spectrum, show that certain individual rays have been stopped, or selected for absorption by the intervening atmospheres; and, though even the few yards of atmosphere between the lamp and the screen absorb, it is not enough to show.

Our spectrum, as it appears before absorption, might be compared to an army divided into numerous brigades, each wearing a distinct uniform, — one red, one green, one blue; so that all the colors are represented each by its own body. If, to represent the light absorbed as it progresses, we supposed that the army advances under a fire which thins its numbers, we should have to consider that (to give the case of nature) this destructive fire was directed chiefly against those divisions which were dressed in blue, or allied colors, so that the army was thinned out unequally, many men in blue being killed off for one in red; and that, by the time it has advanced a certain distance under fire, the proportion of the men in each brigade has been altered, the red being comparatively unhurt. Almost all absorption is thus selective in its action, and often in an astonishing degree; killing off, so to speak, certain rays in preference to others, as though by an intelligent choice, and not only destroying most of certain divisions (to continue our illustration), but even picking out certain files in each company. Every ray, then, has its own individuality, and on this I cannot too strongly insist; for just as two men retain their personalities under the same red uniform, and one may fall and the other survive, though they touch shoulders in the ranks, so in the spectrum certain parts will be blotted out by absorption, while others next to them may escape.

To illustrate this selective absorption, I put a piece of didymium glass in the path of the ray. It will, of course, absorb some of the light; but, instead of dimming the whole spectrum, we might almost say it has arbitrarily chosen to select one narrow part for action, in this particular case choosing a narrow file near the orange, and letting all the rest go unharmed. In this arbitrary way our atmosphere operates, but in a far more complex manner, taking out a narrow file here, and another there, in hundreds of places all through the spectrum, but, on the whole, much the most in the blue, the Fraunhofer lines being merely part of the evidence of this wonderful quasi-intelligent action which bears the name of selective absorption.

Before we leave this spectrum, let us recall one most important matter. We know that here, beyond the red, is solar energy in the form of heat, which we cannot see, but not on that account any less important. More than half the whole power of the sun is here invisible, and, if we are to study completely the action of our atmosphere, we shall have to pay great attention to this part, and find out some way of determining the loss in it; which will be difficult, for the ultra-red end is not only invisible, but compressed, the red end being shut up like the closed pages of a book, as you may notice by comparing the narrowness of the red with the width of the blue.

Now, refraction by a prism is not the only way of forming a spectrum. Nature furnishes us color not only from the rainbow, but from non-transparent substances, like mother-of-pearl, where the irridescent hues are due to microscopically fine lines. Art has lately surpassed nature in these wonderful 'gratings,' consisting of pieces of polished metal, in which we see at first nothing to account for the splendid play of color apparently pouring out from them like light from an opal, but which, on examination with a powerful microscope, show lines so narrow that there are from fifty to a hundred in the thickness of a fine human hair, and all spaced with wonderful precision.

This grating is equal in defining-power to many such prisms as we have just been looking at, but its light does not show well upon the screen. You will see, however, that its spectrum differs from that of the prism, in that in this case the red end is expanded, as compared with the violet, and the invisible ultra-red is expanded still more; so that this will be the best means for us to use in exploring that 'dark continent' of invisible heat found in the spectrum not only of the sun, but of the electric light, and of all incandescent bodies, and of whose existence we already know from Herschel and Tyndall.

Now, we cannot reproduce the actual solar spectrum

on the screen, without the sun itself; but here are photographs of it, which show parts of the losses the different colors have suffered on their way to us. We have before us the well-known Fraunhofer lines, due, you remember, not only to absorption in the sun's atmosphere, but also to absorption in our own. We have been used to think of them in connection with their cause, one being due to the absorption of iron-vapor in the sun, another to that of water-vapor in our own air, and so forth; but now I ask you to think of them only in connection with the fact that each is due to the absorption of some part of the original *light*, and that collectively they tell much of the story of what has happened to that light on its way down to us. Observe, for instance, how much thicker they lie in the blue end than in the red, — another evidence of the great proportionate loss in the blue.

If we could restore all the lost light in these lines, we should get back partly to the original condition of things at the very fount; and, so far as our own air is concerned, that is what we are to ascend the mountain for, — to see, by going up through nearly half of the atmosphere, what the rate of loss is in each ray by actual trial; then, knowing this rate, to be able to allow for the loss in the other part still above the mountain-top; and, finally, by recombining these rays, to get the loss as a whole. Remember, however, always, that the most important part of the solar energy is in the dark spectrum, which we do not see, but which, if we could see, we should probably find to have numerous absorption-spaces in it corresponding to the Fraunhofer lines, but where heat has been stopped out rather than light. To make our research thorough, then, we ought not to trust to the eye only, or even chiefly, but have some way of investigating the whole spectrum, — the invisible, in which the sun's power chiefly lies, as well as the visible, and both with an instrument that would discriminate the energy in these very narrow spaces like an eye to see in the dark; and, if science possesses no such instrument, then it may be necessary to invent one.

The linear thermopile is nearest to it of any, and we all here know what good work it has done; but even that is not sensitive enough to measure in the grating spectrum, in some parts of which the heat is four hundred times weaker than in that of a prism, and we want to observe this invisible heat in very narrow spaces. Something like this has been provided since by Capt. Abney's most valuable researches; but these did not at the time go low enough for my purpose, and I spent nearly a year, before ascending the mountain, in inventing and perfecting the new instrument for measuring these, which I have called the 'bolometer,' or 'ray-measurer.' The principle on which it is founded is the same as that employed by my late lamented friend, Sir William Siemens, for measuring temperatures at the bottom of the sea, which is, that a smaller electric current flows through a warm wire than through a cold one.

One great difficulty was to make the conducting-wire very thin, and yet continuous; and for this purpose, almost endless experiments were made; among other substances, pure gold having been obtained by chemical means in a plate so thin that it transmitted a sea-green light through the solid substance of the metal. This proving unsuitable, I learned that iron had been rolled of extraordinary thinness in a contest of skill between some English and American iron-masters; and, procuring some, I found that fifteen thousand of the iron plates they had rolled, laid one on the other, would make but one English inch. Here is some of it, rolled between the same rolls which turn out plates for an iron-clad, but so thin, that, as I let it drop, the iron plate flutters down like a dead leaf. Out of this the first bolometers were made; and I may mention that the cost of these earlier experiments was met from a legacy by the founder of the Royal institution, Count Rumford. The iron is now replaced by platinum, in wires, or rather tapes, from a two-thousandth to a twenty-thousandth of an inch thick, one of which is within this button, where it is all but invisible, being far finer than a human hair. I will project it on the screen, placing a common small pin beside it as a standard of comparison. This button is placed in this ebonite case, and the thread is moved by this micrometer screw, by which it can be set like the spider-line of a reticule; but by means of this cable, connecting it to the galvanometer, this thread acts as though sensitive, like a nerve laid bare to every indication of heat and cold. It is, then, a sort of sentient thing: what the eye sees as light it feels as heat, and what the eye sees as a narrow band of darkness (the Fraunhofer line) this feels as a narrow belt of cold; so that, when moved parallel to itself and the Fraunhofer lines down the spectrum, it registers their presence.

It is true, we can see these in the visible spectrum. But you remember, we propose to explore the invisible also; and, since to this the dark is the same as the light, it will feel absorption-lines in the infra-red which might remain otherwise unknown.

I have spent a long time in these preliminary researches, in indirect methods for determining the absorption of our atmosphere, and in experiments and calculations which I do not detail; but it is so often supposed that scientific investigation is a sort of happy guessing, and so little is realized of the labor of preparation and proof, that I have been somewhat particular in describing the essential parts of the apparatus finally employed; and now we must pass to the scene of their use.

We have been compared to creatures living at the bottom of the sea, who frame their deceptive traditional notions of what the sun is like from the feeble, changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up towards it; and if these rays grew hotter, brighter, and bluer, as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top. Since we children of the earth, while dwelling on it, are always at the bottom of a sea, though of another sort, the most direct method of proof I spoke of, is merely

to group as far as we can, and observe what happens; though, as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason; and in particular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyze every part of it by some method that will enable us to explore the invisible, as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyze the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting — this selective absorption — began.

It may seem at first that we cannot ascend far enough to do much good, since the surface of our aerial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser that about one-half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do: for ours must not only be very high, but very steep; so that the station we choose at the bottom may be almost under the station we are afterwards to occupy at the top. Besides, we are not going to climb a lofty, lonely summit, like tourists, to spend an hour, but to spend weeks; so that we must have fire and shelter, and, above all, we must have dry air to get clear skies. First I thought of the Peak of Teneriffe; but afterwards some point in the territories of the United States seemed preferable, particularly as the government offered to give the expedition, through the signal-service, and under the direction of its head, Gen. Hazen, material help in transportation, and a military escort, if needed, anywhere in its own dominions. No summit in the eastern part of the United States rises much over seven thousand feet, and, though the great Rocky Mountains reach double this, their tops are the home of fog and mist; so that the desired conditions, if met at all, could only be found on the other side of the continent, in southern California, where the summits of the Sierra Nevadas rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly fifteen thousand feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored; and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired, could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel three thousand miles even to get where the chief difficulties would begin, and make a desert journey of a hundred and fifty miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey, to face such unknown risks of failure. The answer must be, that mountains of easy ascent, and fifteen thousand feet high, are not to be found at our doors, and that these risks were involved in the nature of our novel experiment; so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburgh, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition; and that of the transcontinental railroads enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went three hundred miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not, indeed, know that one feels the triumphs of civilization over the opposing forces of nature anywhere more than in the sharp contrasts which the marvellous luxury of recent railroad accommodation gives to the life of the desert. When one is in the centre of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his dessert, he need not envy the heroes of oriental story who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over three thousand miles to the Mojave desert. It was growing hotter and hotter when the train stopped in the midst of vast sand-wastes a little after midnight. Roused from our sleep, we stepped on to the brown sand, and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilization to those almost of barbarism, as sharp as could well be imagined. We commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seemed to be chiefly inhabited by rattlesnakes of an ashen gray color and a peculiarly venomous bite. There is no water save at the rarest intervals; and the soil at a distance seems as though strewed with sheets of salt, which aids the delusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of 'Death Valley,' from the number of human beings who have perished in it. Formerly an emigrant-train, when emigrants crossed the continent in caravans, had passed through the great Arizona deserts in safety, until, after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them: only this one more valley lay between; and into this they descended, thinking to cross it in a day, but they never crossed it. Afterwards the long line of wagons was found, with the skeletons of the animals in the

harness, and by them those of men, women, and little children, dead of thirst; and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region, — a dryness which so far served our object, which was, in part, to get rid, as much as possible, of that water-vapor which is so well known to be a powerful absorber of the solar heat.

Every thing has an end; and so had that journey, which finally brought us to the goal of our long travel at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices that looked hopelessly insurmountable and wonderfully near. The whole savage mountain region, in its slow rises from the west, and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than any thing I know on the earth. The summits are jagged peaks, like Alpine 'needles,' looking in the thin air so delusively near, that, coming on such a scene unprepared, one would almost say they were large gray stones a few fields off, with an occasional little white patch on the top that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdons piled on one another, and the white patches occasional snow-fields, looking how invitingly cool from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents, and fell to work (for you remember we must have two stations, a low and a high one, to compare the results); and here we labored three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents, a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun; and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart, and packed in small pieces on the backs of mules, who were to carry it by a ten-days' journey through the mountains to the other side of the rocky wall, which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule-trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies that had daily tantalized us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of five thousand feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at six thousand found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it; and, besides, I had begun to have my attention directed to a more personal subject. This was, that the colder it grew, the more the sun burnt the skin — quite literally burnt, I may say; so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold, where the thermometer had fallen to freezing at night; and still, as we ascended, the paradoxical effect increased. The colder it grew about us, the hotter the sun blazed above. We have all heard, probably, of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches; but here, by the end of the fourth day, my face was scarcely recognizable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water-vapor, too; and, on the whole, this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal color of the sun which we had climbed towards it to study.

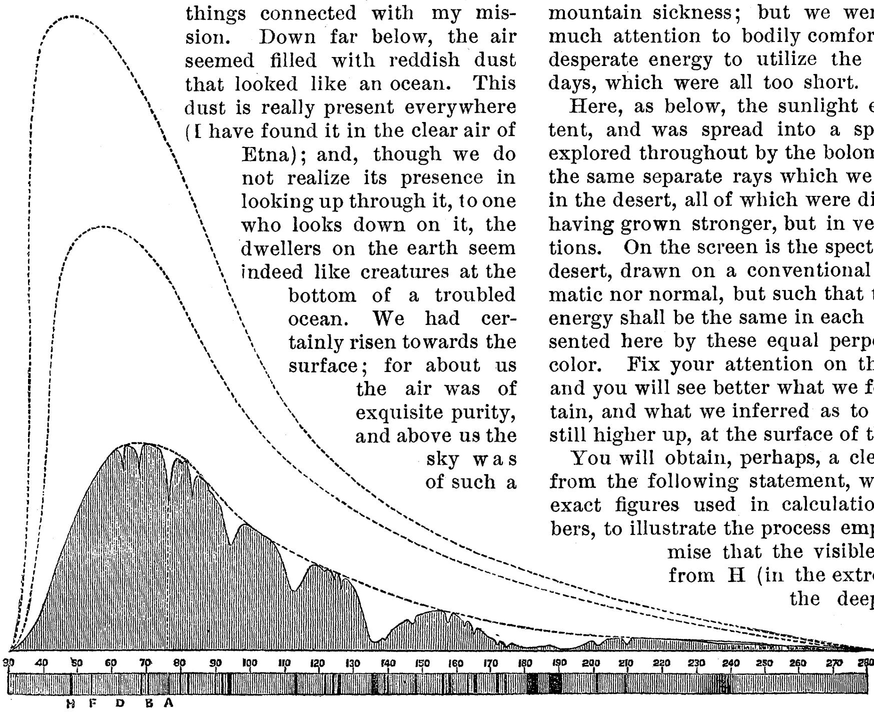
On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the waterfall, at a height of about twelve thousand feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheatre of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below, or even of the peak above us. The air was wonderfully clear; so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes, and from occasional snow-fields on the distant waste of lonely mountain summits on the west.

The mule-train, sent off before by another route, had not arrived when we got to the mountain camp, and we realized that we were far from the appliances of civilization by our inability to learn about our chief apparatus; for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness, we ascended the peak nearly three thousand feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended; and,

in fact, the heavier apparatus was not carried above the mountain camp.

The view from the very summit was over numberless peaks on the west to an horizon, fifty miles away, of unknown mountain-tops; for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame; and, wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking. It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works; but I turned to the study of the special things connected with my mission. Down far below, the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna); and, though we do not realize its presence in looking up through it, to one who looks down on it, the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen towards the surface; for about us the air was of exquisite purity, and above us the sky was of such a deep violet-blue as I have never seen in Egypt or Sicily: and yet even this was not absolutely pure, for, separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge; so that even here we had not got absolutely above that dust-shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent; and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean: for here we were lifted into the great encircling currents of the globe, and, 'near to the sun in lonely lands,' were in the right conditions to study the differences between his rays at the surface, and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak, and hailed with joy the first arrival of our mule-trains with the requisite apparatus at the mountain camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers, and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming three inches deep in the tents at night) and from mountain sickness; but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilize the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different proportions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every color. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aerial sea.



DISTRIBUTION OF SOLAR ENERGY AT SEA-LEVEL AND AT VARIOUS ALTITUDES.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of forty hundred-thousandths of a millimetre in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum. Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way: Fix your attention for a moment on any single part of the spectrum; for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2°, on any arbitrary scale we draw a vertical line, two inches or two feet high, over that part of the spectrum. If the heat at another point, such as 40, were but $\frac{1}{5}$°, a line would be drawn there a quarter of an inch high; and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the 'cold bands' already spoken of. Again: if on top

of the mountain we measure all these over once more, we shall find all are hotter; so that we must up there make all our lines higher, but *in very different proportions*. At 60, for instance, the heat (and light) may have grown from 2° to 3°, or increased one-half, while above 40 the heat (and light) may have grown from $\frac{1}{5}$° to 1°, or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy, whether heat or light, in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain top rises through one-half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and by getting rid of that lower half the ray 60 has grown in brightness from 2 to 3, or half as much again, in going up to the top it would gain half as much more, or become $4\frac{1}{2}$; while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geocentric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained by actual measurement that evidence which we sought; and by thus reproducing the spectrum outside the atmosphere, and then recombining the colors by like methods to those you have seen on the screen, we finally get the true color of the sun, which tends, broadly speaking, to blue.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds any thing except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat-region still but so partially known, or, rather, I was mapping in that great 'dark continent' of the spectrum, and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey farther than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the Ultima Thule of previous travellers, and finally came to what seemed the very end of the invisible heat-spectrum, beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task, when it occurred to me to advance the bolometer still farther; and I shall not forget the surprise and emotion with which I found new and yet unrecognized regions below, — a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying, that, after we got down to lower earth again, the explorations and mapping of this new region was continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum; while its length upon the wave-length scale is equal to all that previously known, visible and invisible, as you will see better by this view, having the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is, Both of them. Both, rightly interpreted, mean just the same thing; but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was at first in doubt about; but more recent researches at Alleghany make it probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have staid longer, in spite of physical discomfort; but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On Sept. 10 we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the eastern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung round the shoulder of the rocks — to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis, where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part way down, as we followed the ice-stream between the tremendous walls of the defile which rose two thousand feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain torrent, and, looking up the long vista of our day's descent, we saw it terminated by the peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequalled for a physical observatory, is likely, I am glad to say, to be utilized; the president of the United States having, on the proper representation of its value to science, ordered the reservation, for such purposes, of an area of a hundred square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilization, where we began to gather the results of our observation, and to reduce them; to smelt, so to speak, the metal from the ore we had brought home, — a slow but necessary process, which has occupied a large part of two years. The results, stated

in the broadest way, mean that the sun is blue, but mean a great deal more than that; this blueness in itself being, perhaps, a curious fact only, but, in what it implies, of practical moment. We deduce in connection with it a new value of the solar heat, so far altering the old estimates, that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible in its practical bearings, of exerting over one-horse power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from the atmosphere is nearly double what has been heretofore supposed. We have found it probable that the human race owes its existence and preservation to the heat-storing action of the atmosphere even more than has been believed.

The direct determination of the effect of water-vapor in this did not come within our scope; but that the importance of the blanketing action of our atmospheric constituents has been in no way over-stated, may be inferred when I add that we have found by our experiments, that, if the planet were allowed to radiate freely into space, without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations; but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our heads, and about us, is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and, as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches: but, practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science; and that, if not in our own hands, then in those of others when our day is over, they may find the best justification for the trouble of their search in the fact that they prove of some use to man.

May I add an expression of my personal gratification in the opportunity with which you have honored me of bringing these researches before the Royal institution, and my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find from light in its fulness what unsuspected agencies are at work to produce for us the light of common day.

NOTES AND NEWS.

THE Committee on meteorology, instituted by the International congress of meteorology, will meet for a third session in Paris in the beginning of the coming September. Up to the present time, the following questions have been proposed for consideration during this session: 1°. Report of the secretary on the labors of the committee since the meeting at Copenhagen; 2°. Report of Messrs. Brito Capello, Hildebrandsson, and Ley, on the observation of the cirrus; 3°. Does it seem opportune to soon convene a third international congress of meteorologists? 4°. Establishment of stations of the first order on the Kongo; 5°. Discussion on the utility of the summaries of the state of the weather as published in the different countries, and the eventual preparation of a plan for more uniformity; 6°. Discussion of the utility of the meteorological telegrams from America proposed by Gen. Hazen, and of an eventual organization for their distribution in Europe; 7°. By what means can the timely receipt of meteorological telegrams be assured? 8°. Should the reduction of barometer readings to gravity under 45° of latitude be generally introduced? 9°. Is it desirable to also count in meteorology the hours of the day from 1 h. to 24 h. according to the resolutions of the international conference in Washington? 10°. Designation for a uniformly covered sky according to the form of the clouds; 11°. Definition of rain and snow days; 12°. Should not the general adoption of a uniform height above the earth for rain-gauges be recommended? 13°. What progress has been made lately in the more exact measurement of snow; 14°. International meteorological tables; 15°. Modification of the rules for the administration of the international committee. Any meteorologists intending to submit to the committee remarks on one or the other of these questions, or to propose other questions, can address Mr. Robert H. Scott, Meteorological office, 116 Victoria Street, London.

— The French Academy of inscriptions and belles-lettres offers the Bordin prize in 1887 for the best treatment of the subject, 'A critical examination of the geography of Strabo.' Competitors are invited, 1°, to review the history of the constitution of the text of the work; 2°, to compare the language of Strabo with that of contemporaneous Greek writers, such as Diodorus Siculus, etc.; 3°, to classify the original observations of Strabo, and segregate them from such as are merely quoted by him from other authorities; 4°, to draw such definite conclusions as the above-mentioned studies may suggest. The memoirs, under the usual conditions, should be deposited with the secretary of the academy at Paris by the 31st of December, 1886.

— The fifth German geographical congress was held at Hamburg, April 9–11 last, under the auspices of a local committee.

— A meeting of the American metrological society was held at Columbia college on Wednesday, May 20. Several interesting communications were made.

— The *Geographisches jahrbuch* (Gotha), now edited by H. Wagner since the death of its founder, Behn, will hereafter appear in two annual parts, with alternating contents, instead of as a single volume every two years, as heretofore. The part of volume x. just

issued contains reviews of physics of the earth, by Zöppritz; geographic meteorology, by Hann; European geodesy, by Oppolzer; geography of plants by Drude, of animals by Schmarda; and ethnological investigation, by Gerland. It is as indispensable as the earlier volumes to those who wish the broader view of these comprehensive subjects.

— The following temperatures and specific gravities of surface water in the Mississippi River were taken on March 1 and 2, 1885, from the South Pass to the mouth of the river, by the officers of the U. S. fish-commission steamer Albatross. From 7 P.M. of March 1, to 3 A.M. of March 2, the course of the ship was S.E. ¾ E., with a speed of 8.2 knots.

Hour.	Locality.	Corrected temperature, F.	Specific gravity reduced to temperature of 60° F.
5 P.M.	South Pass	41°	1.00136
5.30 "	Jetties	41°	1.00136
6 "	Off Jetties	54°	1.01039
7 "	" "	58°	1.01413
8 "	" "	58°	1.01495
9 "	" "	62°	1.01514
10 "	" "	57°	1.01820
11 "	" "	58°	1.01989
12 M.	" "	64°	1.02564
1 A.M.	" "	65°	1.02714
2 "	" "	66°	1.02754
3 "	" "	61°	1.02809
6.27 "	Lat. 28° 00′ 15″ N. Long. 87° 42′ 00″ W.	66°	1.02823
8 P.M.	Lat. 28° 05′ 00″ N. Long. 87° 56′ 15″ W.	66°	1.02819

— Capt. Magee of the schooner Henry Waddington reports that he passed close to a white whale on March 1, in latitude 27° 3′ north, longitude 75° 30′ west. This position off the Bahamas is unusual, as the white whale is usually found in northern waters. The portion of the whale seen was entirely white, and about thirty feet long.

— Dr. Klein has been experimenting with chlorine as an air-disinfectant, especially in respect to swine-disease, this being easily conveyed by the air. He experimented with two pigs — one healthy, the other diseased — confined in the same stable, and in an atmosphere impregnated with as much chlorine as the animals could endure without evincing discomfort. The healthy pig remained well for as long a time as six hours, for five successive days, provided the air in the compartment was maintained well-fumigated with chlorine gas; two good fumigations, up to a marked pungency in the six hours, being required. One good fumigation would effectually disinfect a compartment in which a diseased pig had been.

— A new map of north-western Afghanistan, on the larger and more convenient scale of ten miles to the inch, has been issued by the English war office.

— The increase in the price of boxwood for loom-shuttles has directed attention to the possibility of producing some cheaper material equally suitable. It has been found that compressed teak will answer the purpose; and a powerful hydraulic press has just been completed by Sir Joseph Whitworth of Manchester, Eng., for Mr. Robert Pickles of Burnby, to be used in compressing this class of timber for the manufacture of loom-shuttles.

— Baron Miklouho-Maclay writes to *Nature* from the biological station near Sydney, Australia, that he has found the temperature of the body of Echidna hystrix to be (average of three observations) 28° C., and that of Ornithorhynchus paradoxus (two observations) 24.8° C. These temperatures present a special interest, comparing them with the mean temperature of the body of mammalia in general, which is (after Dr. J. Davy's observations of thirty-one different species) 38.4° C.

— The hydrographical researches in Davis Strait, says *Scandinavia*, further corroborate the evidence that there exists in this place a warm undercurrent; for it was found that the highest temperature, when the depth is more than a couple of hundred fathoms, is nearest the bottom. The results of the haulings and scrapings, extending to a depth of three hundred fathoms, in Davis and Disco Bays, were many varieties of lower animals, a few of which were new species. Davis Strait is a favorite ground for deep-sea dredging; for on the 28th of June, 1845, Henry Godrey, a member of the Sir John Franklin expedition, obtained in Davis Strait, from the depth of three hundred fathoms, a capital haul, — Mollusca, Crustacea, Asterida, etc.

— Dr. Leonard Weber published in the *Elektrotechnische zeitschrift* a paper on the estimation of the illumination which a light of any given strength would give upon a table, or on a wall, or any other object which it might be desired to illuminate; his point being to consider not only the intensity of the source of light, but also the position in which the light should be placed to render it available to the highest degree.

— Woeikof of St. Petersburg contributes to the Geneva *Archives des sciences* a sample chapter in French from his recent work in Russian on climatology, describing the supply and discharge of the rivers and lakes of Russia. The most characteristic examples of river-discharge of the Russian type include such rivers as the Volga, Kama, and Moskva, which rise to high flood regularly once a year in April or May, when the winter snowfall melts and flows away. The Moskva, which has been carefully gauged in recent years, discharged 93,000,000 cubic metres in the twenty-five days from April 16 to May 10: during the rest of the year, the total discharge was only 85,000,000. The Neva, a lacustrine river, is, of course, much more regular in its flow: it carries out about one-eleventh of the volume of Lake Ladoga every year. Evaporation on the Caspian is estimated at a little over a metre a year, but fine exactness is not claimed for this result.

— The long series of experiments made during last summer and autumn at the South Foreland light, England, to test the respective merits of oil, gas, and electricity, for lighthouse illumination, will shortly be

reported. The result is strongly in favor of electricity. The electric light could be seen fourteen miles when the others were lost sight of at eight miles; and, when the others were at a maximum power of ten miles, the electric light could be seen at fourteen and a half; and, though its power is much diminished by fog, it is still superior to all other lights, — a point hitherto doubtful.

— In consequence of the increase of shortsightedness, and the theories current as to its cause, a new departure in book-printing has been made in Holland, the letters being printed in dark blue on a pale-green page. Messrs. Issleib of Berlin have also printed one of their latest publications, 'Die naturgeschichte der Berlinerin,' in this manner, but the result is not wholly satisfactory.

— *Scandinavia* states that H. C. Muller, who, as 'Sysselmand,' has been present at a large number of 'drivings' of whales at the 'Faroer,' has recently described, in the Proceedings of the Natural-history society at Copenhagen, the process of catching the grindehval. The largest number are caught in the months of June, July, August, and September. A few wounded specimens are found to be troubled with parasites, small white crustaceans, rarely by cirripedes. It has an enemy in Delphinus orca, the marks of whose teeth have often been observed on it; but that Lagenorhynchus Eschrictii or Delphinus turrio should bite it, is a fable, for its mouth is too little and its teeth too small to do the grindehval any harm. Besides, it feeds on the same food as the grindehval, viz., squids. The news of the arrival of the whales spreads like fire. From every village people hasten to the place. By throwing stones the whales are driven into the bay, whence they are either dragged on land and killed, or slain with knives on the shallow places. Then, after the whales have been killed, a division of the catch is made by the participants, certain portions being reserved for the state, church, and school funds.

— Professor Kiessling of Hamburg has given especial attention to the famous sunset question, and during the past year has devised a number of experiments for illustrating the action of minute solid or liquid particles on sunlight, by which sky colors are produced. He has lately summarized his results in a pamphlet entitled 'Die dämmerungserscheinungen in jahre 1883 und ihre physikalische erklärung.' Diffraction is considered the most important optical process that contributes to the result, as the dull reddish ring around the noonday sun, the horizon colors at sunset, and the purple and other glows half an hour later, are all ascribed to this action. The explanation of the purple and pinkish glows is especially apt and ingenious, and more to the point than any other solution of the question that has been presented. An important supplement to his pamphlet describes the construction of an apparatus designed to illustrate his explanations experimentally. He is a strong supporter of the volcanic origin of the particles on which the diffracting water-particles have condensed.

— We learn from *Scandinavia* that Professor Falbe Hansen of the University of Copenhagen delivered recently a very interesting lecture upon the progress of Denmark in recent times, especially after the free constitution of 1848. During the last century, the yearly increase of the population was nearly 2,000; after 1840, 17,000. Copenhagen had, in 1840, 124,000 inhabitants, while it now has 330,000. The provincial towns rose in the number of its inhabitants from 148,000 in 1848, to 304,000. Early in the century, at the accession of King Frederick VI., the national wealth could be computed at 530,000,000 crowns; in 1848, at the accession of Frederick VII., at 1,000,000,000; at his death in 1863, at 2,300,000,000; and now, at 4,000,000,000. Denmark cannot any longer justly be named, as formerly by the poet, 'a poor little country.'

— Miss E. A. Ormerod has just issued her eighth annual report of "Observations of injurious insects and common farm pests during the year 1884, with methods of prevention and remedy." It embodies the remarks of numerous observers in various parts of Great Britain on the occurrence of insects injurious to farm and garden crops, on their habits, and on the best ways of getting rid of them. It is not a little remarkable, says *Nature*, to notice how observant, often of minute and interesting details, Miss Ormerod's correspondents are; and, though many of them probably have little or no scientific training, their aptitude for studying the habits and effects of certain insects makes their records of considerable value. Aside from the scientific interest of the report, Miss Ormerod has done a good work in inculcating habits of observation among farmers and gardeners, who have opportunities such as few others have for noticing facts connected with the life-histories of insects.

— In the January number of the *Journal of anatomy and physiology*, Dr. Alexander Hill describes a very interesting parasitic monster which he recently dissected. The parasitic twin consisted of a lobulated mass projecting from the anterior nares of a more perfect foetus. The mass is about as large as the head of the other foetus, and is divided into three large and six small cotyledons. In one of the large lobes there is an embryonal form of liver; in another a central irregular mass of bone, full of cysts. From a study of this parasite, Dr. Hill concludes that the foetus is a double monster, one part of which has been arrested in development by some mechanical advantage which the more perfect foetus possessed over the other in the beginning; and that the parasite did not begin to develop until after the perfect twin was rather far advanced. The parasite is well supplied with blood, and the skin is well developed; but the larger part of its mass is made up of jelly-like embryonic tissue.

— A German engineer is reported to have invented a method of ascending and descending in a balloon at pleasure until he finds a current of air moving in the horizontal direction he wishes. The agent he uses is compressed carbonic acid, with which he is enabled to condense or expand the gas.